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ABSTRACT

Experiment I was designed to demonstrate that young children fail to abstract the positive cue as the relevant stimulus event in a restricted concept-learning task. Sixteen kindergarten and 16 fourth grade subjects were trained to criterion on a Kendler-type task, whereupon each subject was presented a pair of new instances which contrasted only in the original cues of the original relevant dimension. Fourth graders selected significantly more positive than negative cue instances on the transfer task, indicating they had indeed abstracted attributes from instances. Kindergarteners, however, selected precisely half of either cue instance, indicating failure to abstract the criterial attribute. Results contradict an assumption common to concept-shift studies. Experiment II was designed to show whether subjects attend to the dimensionality of a discriminated attribute in a concept-shift task. The subjects were 20 kindergarteners and 20 fourth graders assigned randomly by age group to an intra-dimensional or to an extra-dimensional shift, where dimensions were the same as in original learning, but all the cues were new. The subjects at both age levels performed significantly better on the intra-dimensional shift, supporting an attention-to-dimensionality hypothesis. Results were related to the concept-shift literature. (Author)

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## Instance, Cue and Dimension Learning in Concept-Shift Tasks

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Experiment I was designed to demonstrate that young children fail to abstract the positive cue as the relevant stimulus event in a restricted concept-learning task. Sixteen kindergarten and 16 fourth-grade Ss were trained to criterion on a Kendler-type task, whereupon each S was presented a pair of new instances which contrasted only in the original cues of the original relevant dimension. Fourth-graders selected significantly more positive than negative cue instances on the transfer task, indicating they had indeed abstracted attributes from instances. Kindergarteners, however, selected precisely half of either cue instance, indicating failure to abstract the criterial attribute. Results contradict an assumption common to concept-shift studies.

Experiment II was designed to show whether Ss attend to the dimensionality of a discriminated attribute in a concept-shift task. The Ss were 20 kindergarteners and 20 fourth-graders assigned at random by age group to an intra-dimensional or to an extra-dimensional shift, where dimensions were the same as in original learning, but all the cues were new. The Ss at both age levels performed significantly better on the intra-dimensional shift, supporting an attention-to-dimensionality hypothesis. Results were related to the concept-shift literature.

Accounts of the processes employed in the solution of concept-shift discrimination problems vary. Buss (1953) attributed superiority of reversal (RV) shifts to intermittent reinforcement which impeded the solution of extra-dimensional (ED) shift problems. Other theorists attribute the phenomenon to acquisition of a mediating response. Kendler and D'Amato (1955) proposed a two-stage mediational theory to account for RV shift superiority, wherein an implicit verbal response to the relevant dimension serves as a conceptual mediator for solving the problem. The mediator, according to Sutherland (1959), is the "switching in" of an appropriate stimulus analyzer. Observing the relevant dimension is the mediating response proposed by Zeaman

and House (1963). Excellent reviews of the literature on discrimination learning employing the concept-shift paradigm are available in papers by Wolff (1966) and by Slamecka (1968).

The problem-solving behavior of very young children given concept-shift tasks may differ in quality from older children and adults. A clear and complete account of the Kendler model appears in Kendler and Kendler (1962). A two-stage mediational device describes concept-shift behavior of articulate beings, but a single unit S-R mechanism characterizes the mental processes of young children and infra-humans, who perform better on ED than on RV shifts. The many flaws inherent in an RV shift procedure are pointed out by Slamecka (1968), who suggests that very young children may simply lack the deductive capacity to take advantage of an obviousness-of-solution factor available in an RV shift of the conventional binary bi-dimensional task. Instead of the RV shift procedure, Eimas (1966) used a total change design in which all stimulus values on all dimensions were changed upon shift to the transfer task. An intradimensional (ID) transfer was substituted for the RV shift, and the ED shift was retained. Even young children showed superior performance given the ID procedure as compared to the ED procedure. The results of the Eimas (1966) study, indicating that younger children use a mediational process, dimensional in nature, as effectively as older children, fault the Kendler and Kendler (1962) one stage model. Eimas' (1965) proposition that "...all organisms mediate and their ability to do so is not related to either their phylo- or ontogenetic status" seems a bit extreme.

The focus of the present investigation is on the processes employed by young children in discrimination transfer problems. Kendler and Kendler (1962) note that the functional stimuli are not restrictively specified in their model. For example, the effective stimuli in a single unit model might include both relevant and contextual stimuli, or might include only the consistently reinforced stimuli. Effective stimuli in the mediational model might be the relevant dimension, or the positive attribute, or both. Experiment I was designed to show whether young children have abstracted the positive attribute as the relevant stimulus event in a transfer problem following discrimination learning. Experiment II was designed to show, in partial replication of the Eimas (1966) study, whether young children transfer dimensional relevance in a discrimination learning total change design. Older children, who were expected to be able to transfer both attributive and dimensional information, served as control Ss.

## Experiment I

### Method

Materials and apparatus. The apparatus was a wooden box (20" x 20" x 10") with two one-way windows (3" x 3"). A pair of stimulus figures behind the windows was exposed simultaneously by fluorescent illumination, at 5-sec on and off timer-controlled intervals. A response button was located below each window. An incandescent bulb mounted on top of the box lighted when the correct response button was pressed. The connection between the light and the varying right-left correct response button was controlled by a knife switch.

Training discriminanda were squares which varied on two values on each of two dimensions: large (L) or small (S) size; and black (B) or white (W) brightness. All values were represented in each presentation pair (LB & SW, and SB & LW), and right-left position of the pair members was randomly alternated.

Transfer materials were squares which varied only on the previously relevant dimension. For Ss trained to select B squares, transfer materials were one B and one W middle-sized square. For Ss trained to select L squares, transfer materials were one L and one S red square.

Subjects. The Ss were 16 kindergarten children aged 59 to 71 months ( $\bar{X} = 64.7$ ), and 16 fourth-graders aged 105 to 123 months ( $\bar{X} = 117.6$ ).

Procedure. The Ss were randomly assigned by age group in order of appearance in the laboratory to one of two cue-learning conditions:

either B correct, or L correct. The S was instructed he would see two figures in the windows, and was to press the button for the correct figure. He was told the light on top of the box would go on each time he was right, and when he learned to make the light go on each time he pushed the button, that he would have won the game. Stimulus pairs were either LB  $\bar{c}$  SW squares or LW  $\bar{c}$  SB squares.

After reaching a criterion of 10 consecutive correct responses, the S was transferred to a new pair of stimuli having the same two values of the relevant dimension as in training, but having a single new value of the previously varying irrelevant dimension.

#### Results

When kindergarten Ss trained to select B squares, regardless of L or S size, were asked to choose between B and W middle-sized squares, 5 chose B, and 3 chose W. In like manner, when kindergarten Ss trained to select L squares, regardless of B or W brightness, were transferred to L or S red squares, 3 chose L, and 5 chose S. Over-all, precisely half the kindergarten Ss selected the square having the same value as the positive instances of training, and half selected exemplars of negative instances,  $\chi^2$  (1 df) = 0.00,  $p > .95$ . It may be noted that a 50-50 distribution was also observed in pilot data. These results suggest that during training, the Ss had learned to identify which particular two instances were correct by responding to the combination of identifying attributes, and that the Ss had not isolated the relevant attribute as the basis for responding. When presented with novel instances which

varied only on the relevant dimension, the Ss guessed as if they had no prior information, showing a perfect 50-50 distribution over the positive and negative exemplars.

When fourth grade Ss were transferred to the new pairs, 6 of the 8 trained on B chose B, and all 8 trained on L chose L. The tendency by fourth graders to choose the instance exemplifying the positive training cue was reliable,  $\chi^2 (1 \text{ df}) = 9.00 \text{ } p < .01$ , indicating they had abstracted the relevant attribute as the basis for responding.

## Experiment 2

### Method

Materials and apparatus. The apparatus was the same as in Experiment I. Training and transfer materials were subject to the same restrictions as the training materials of Experiment I. Varying dimensions were form and color. Training materials were Black (B) or White (W) Squares (S) or Circles (C). Transfer materials were Red (R) or Blue (Bu) Triangles (T) or Bars (Br).

Subjects. The Ss were 20 kindergarten children aged 57 to 73 months ( $\bar{X} = 64.9$ ) and 20 fourth-graders aged 105 to 127 months ( $\bar{X} = 116.7$ ).

Procedure. The Ss were randomly assigned by age group, in order of appearance in the laboratory, to one of two shift conditions: Intradimensional Shift (ID), or Extradimensional Shift (ED); and to one of two Materials conditions: transfer to Red correct (R), or transfer to Triangle correct (T). In each age group, 5 Ss trained on

B were transferred to R (ID): 5 trained on B were transferred to T (ED); 5 trained on S were transferred to T (ID); and 5 trained on S were transferred to R (ED). Instructions corresponded to Experiment I. Criterion was 10 consecutive correct responses for both training and transfer.

### Results

The dependent variable was trials to criterion. A summary of the data appears in Table I and data analysis is summarized in Table 2.

Table I

Means and SDs of Trials to Criterion in Concept Shift Task of Experiment II

| Kindergarten      |       | Age               |       | Fourth Grade      |       |                   |       |       |
|-------------------|-------|-------------------|-------|-------------------|-------|-------------------|-------|-------|
| INTRA-DIMENSIONAL |       | EXTRA-DIMENSIONAL |       | INTRA-DIMENSIONAL |       | EXTRA-DIMENSIONAL |       |       |
| Mean              | SD    | Mean              | SD    | Mean              | SD    | Mean              | SD    |       |
| Color             | 21.00 | 9.92              | 38.00 | 20.28             | 10.60 | .89               | 22.20 | 14.32 |
| Form              | 17.40 | 12.08             | 25.00 | 17.00             | 13.40 | 4.72              | 15.40 | 6.54  |

Table 2

Summary of the Analysis of Variance for Concept Shift Task of  
Experiment II

| Source         | df | MS          | F      |
|----------------|----|-------------|--------|
| Age            | 1  | 990.025     | 6.405* |
| Shift          | 1  | 912.025     | 6.901* |
| Materials      | 1  | 265.225     | 1.716  |
| A x S          | 1  | 75.625      | < 1    |
| A x M          | 1  | 225.625     | 1.459  |
| S x M          | 1  | 99.225      | < 1    |
| A x S x M      | 1  | .025        | < 1    |
| Within (Error) | 32 | 145.55      |        |
| Total          | 39 | * $P < .05$ |        |

Fourth-graders succeeded in the concept shift in significantly fewer trials than did the kindergarteners,  $F(1, 32) = 6.40$ ,  $p < .05$ . Mean trials were 15.40 and 25.35 respectively. The ID task ( $\bar{X}$  trials = 15.60) was reliably easier than the ED task ( $\bar{X}$  trials = 25.15),  $F(1, 32df) = 6.90$ ,  $p < .05$ . The important finding is that the interaction between Age and Shift was not significant ( $F < 1$ ), indicating that the relative easiness of ID over ED was consistent across age groups. The near-parallel performance of the two Age levels on the Shift tasks is represented in Figure I.

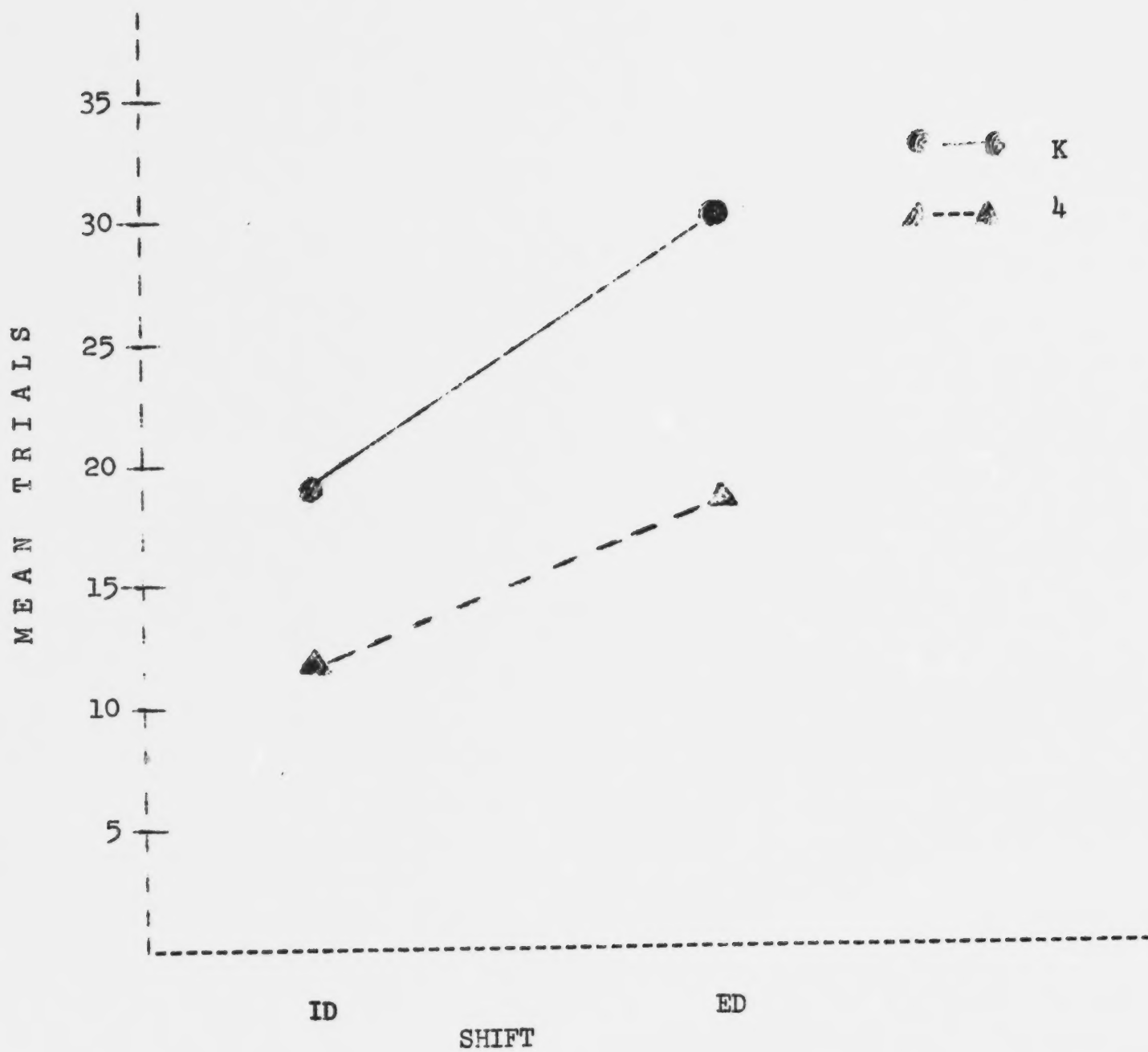


Figure 1. Mean trials for discrimination learning given an intradimensional or an extradimensional shift, at two age levels.

### Discussion

The results of Experiment II are in agreement with the results of Eimas' (1966) study, in which even young Ss show transfer effects attributable to dimensional relevance, and the results are in disagreement with the single unit theory of Kendler and Kendler (1962).

The two stage mediational model set forth by Kendler and Kendler (1962) loses power when the results of Experiments I and II are taken together. That is, if the nature of the mediating chain is (a) a response identifying the relevant dimension, which serves as (b) a cue triggering the overt (correct) response to the positive attribute, then that same chain of habits would be operating for both Experiment I and II, and would be exactly appropriate for correct solution in the transfer task of Experiment I. The Zeaman and House (1963) model is similarly weakened. The two-response chain made up of a dimensional observing response linked to an instrumental cue response would also, if correctly learned during training, be exactly appropriate for correct solution in the transfer task of Experiment I. It is possible that the mediating response chain is particularly susceptible to being disrupted in very young children by the introduction of novel irrelevant stimuli. However, it seems unlikely that such disruption would be complete, and only a total disruption of the chain would predict guessing behavior on the transfer task of Experiment I.

The Tighe and Tighe (1966) proposal that immature Ss analyse stimuli into weakly differentiated complexes such as stimulus compounds pro-

vides an appealing interpretation of the data of Experiment I. The younger Ss obviously had not abstracted the positive cue as the basis for responding. Nonetheless, they evidenced an attentional shift to the relevant dimension in Experiment II. It appears that the relevant dimension accrues an attentional potency in a discrimination learning task, but that immature Ss lack the logical capacity to use the positive cue abstracted from its context to solve a novel two-choice problem.

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